Search Summary

Some material from: D Lin, J You, JC Latombe
Search Summary #1

- Problem Solving as Search
- Blind Search Techniques
  - Breadth-first (uniform cost)
  - Depth-first
  - “Iterative Deepening”
  - Bi-Directional
- Time/ Space Complexity:
  Size of search space: $\approx 10^{11}$ nodes
Search Summary #2

- Heuristic Search Techniques
  ... using “Distance to Goal”
  - Best-First
  - A*: provably optimal!
    Search space $\approx 10^{25}$ nodes (IDA*)
- Heuristic Functions
Search Summary #3

- Constraint Satisfaction Problems
  - Intro CSP (Def’n, Types, Examples)
  - Complexity
  - Tricks for “Grow” approach
    - (arc) consistency + propagation
    - Backward checking (DFS)
    - Forward Checking
    - Variable / Value ordering
- Constraint Optimization Problems
Search Summary #4

- Iterative Algorithms
  - Framework, Examples
  - Hill-climbing / Gradient Descent
  - Problem / Issues
  - GSAT, WalkSat
- Other approaches
  - Simulated Annealing, Tabu, Random Restarts, Genetic Algorithms

⇒ Search space ≈ $10^{100}$ to $10^{1000}$
Search Summary #5

- Adversary Search / Game Playing
  - Minimax
    - \( \approx 10^{10} \) nodes, 6-7 ply in chess
  - Alpha-beta Pruning
    - \( \approx 10^{20} \) nodes, 14 ply in chess
    - provably “optimal”
Other Topics

- wrt Search
  - Iterative BROADENING
  - Memory Bounded Search – SMA*
  - Beam Search
  - Island Hopping – abstraction
  - …

- wrt CSPs
  - Backjump
  - Dynamic Orderings
  - Special cases (eg, when arc-consistency is sufficient)
Search and AI

Q: Why such a central role?
A: As many AI tasks are **ill-specified** and/or **intractable**, Search is ONLY approach


- Good news:
  - Tremendous recent progress
    - $10^{30}$ feasible; often to $10^{1000}$
  - QUALITATIVE DIFFERENCE from only a few years ago!!